CLAIMS:

1. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, comprising the steps of:

inputting a jth time pulse on an nth detector channel, the nth detector channel being one of the N detector channels, the jth time pulse comprising a jth position in time, corresponding to a time-of-occurrence of a jth event, j being an integer from 1 to J, J representing a total number of events recorded on the block;

generating a jth time signal, the jth time signal representing a time-of-occurrence of the jth time pulse, the jth time pulse being asynchronous to a clock signal;

generating a jth address signal, the jth address signal comprising an nth address, the nth address representing the nth detector channel recording the jth event, the jth address signal being synchronous to the clock signal;

generating a jth detector channel signal, the jth detector channel signal comprising the jth time signal and the jth address signal;

generating a composite signal, the composite signal comprising at least one of the J detector channel signals from at least one of the N detector channels; and

outputting the composite signal serially over a data link.

2. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 1, further comprising the step of adapting the method for use in obtaining an image of a conscious animal brain.

3. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 1, further comprising the steps of:

inputting jth energy information on the nth detector channel, the jth energy information representing an energy content of the jth event;

generating a jth energy signal, the jth energy signal comprising a jth energy pulse, the jth energy pulse comprising a position representing the jth energy information, the jth energy pulse being asynchronous to the clock signal; and

incorporating the jth energy signal in the jth detector channel signal.

4. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 1, further comprising the step of

incorporating a synchronous delay between the jth time signal and the jth address signal.

5. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 1, wherein the jth detector channel signal comprises a jth packet comprising information representing the jth time signal and the jth address signal, further comprising the step of determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} = (\log_2(N) + 2) * T_{clock} \qquad (1),$$

N representing a quantity of detector channels, T_{clock} representing a period of the clock signal.

6. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 1, wherein the jth detector channel signal comprises a jth packet comprising information representing the jth time signal and the jth address signal, the method further comprising the step of determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} \langle\langle 1/(N * rate) \qquad (2),$$

N representing a quantity of detector channels, *rate* representing an average event rate per detector channel.

7. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 1, further comprising the steps of:

inputting a $(j + 1)$th time pulse, the $(j + 1)$th time pulse comprising a position representing a time-of-occurrence of a $(j + 1)$th event, the time-of-occurrence of the $(j + 1)$th event being substantially the same as the time-of-occurrence of the jth event; and

disregarding one of the jth event and the $(j+1)$th event in accordance with a priority scheme.

8. A method of transferring annihilation information from a block comprising N detector channels in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, where N is an integer greater than one, an nth detector channel corresponding to a physical location of an nth detector on the block, as defined by Claim 7, wherein the priority scheme includes the step of disregarding one of the jth event and the $(j + 1)$th event associated with a lower channel address.

9. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, the apparatus comprising:

at least one pair of opposing blocks, each block of the at least one pair of opposing blocks comprising *N* detector channels, an *n*th detector channel being one of the *N* detector channels and corresponding to a physical location of an *n*th detector on the block, each block of the at least one pair of opposing blocks comprising:

an *n*th time signal generator associated with the *n*th detector channel, a *j*th time pulse being input to the *n*th time signal generator on the *n*th detector channel, the *j*th time pulse comprising a position representing a time-of-occurrence of a *j*th event, the *n*th time signal generator generating a *j*th time signal, the *j*th time signal representing a time-of-occurrence of the jth time pulse, the jth time pulse being asynchronous to a clock signal, *j* being an integer from 1 to J, J representing a total number of events recorded on the block;

an address signal generator generating an *n*th address representing the *n*th detector channel at which the *j*th event is recorded, the address signal generator generating a *j*th address signal, the *j*th address signal comprising the *n*th address representing the *n*th detector channel at which the *j*th event occurred, the *j*th address signal being synchronous to the clock signal; and

a detector channel signal generator, generating a *j*th detector channel signal, the *j*th detector channel signal comprising the *j*th time signal and the *j*th address signal, and outputting a composite signal serially over a data link, the composite signal comprising at least one of the J detector channel signals from at least one of the *N* detector channels.

10. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a

conscious animal, as defined by Claim 9, wherein the apparatus is adapted for use in obtaining PET images of an animal brain.

11. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, further comprising an energy signal generator, the energy signal generator inputting jth energy information on the nth detector channel, the jth energy information comprising an energy content of the jth event, the energy signal generator generating a jth energy signal, the jth energy signal comprising a jth energy pulse, the jth energy pulse comprising a position representing the jth energy information, the jth energy pulse being asynchronous to the clock signal, the detector channel signal generator incorporating the jth energy signal in the jth detector channel signal.

12. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the detector channel signal generator incorporates a synchronous delay between the jth time signal and the jth address signal.

13. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the detector channel signal generator generates a jth packet, the jth packet comprising information representing the jth time signal and the jth address signal, the detector channel signal generator determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} = (\log_2(N) + 2) * T_{clock} \qquad (1),$$

N representing a quantity of channels, T_{clock} representing a period of the clock signal.

14. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the detector channel signal generator determines a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} \langle\langle 1/(N * rate) \qquad (2),$$

N representing a quantity of channels, *rate* representing an average rate of events per detector channel.

15. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, further comprising:

a priority encoder, the priority encoder disregarding one of the jth event and a $(j + 1)$th event, the time-of-occurrence of the jth event being substantially the same as the time-of-occurrence of the $(j + 1)$th event.

16. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 15, wherein the priority encoder disregards one of the jth event and the $(j + 1)$th event associated with a lower channel address.

17. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the apparatus is adapted for implementation in an Application Specific Integrated Circuit (ASIC).

18. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the *n*th time signal generator comprises a flip-flop, the flip flop being clocked by the *j*th time pulse, the flip flop outputting the *j*th time signal.

19. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the address signal generator comprises a shift register, the shift register being loaded with the *n*th address in response to the *j*th time signal, the shift register being clocked by the clock signal.

20. An apparatus to serially transfer annihilation information in a conscious animal positron emission tomography (PET) scanner used to image a portion of a conscious animal, as defined by Claim 9, wherein the detector channel signal generator comprises combinatorial logic, the combinatorial logic incorporating the *j*th time signal and the *j*th address signal in the *j*th detector channel signal.

21. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal, comprising:

a ring tomograph, the ring tomograph comprising an inner surface, the inner surface mounting onto and substantially surrounding the portion of the conscious animal, at least one block pair, at least one of the at least one block pair comprising a first block and a second block, the second block being positioned opposite the first block on the ring tomograph, each of the first block and the second block comprising:

a scintillator layer, the scintillator layer outputting at least one photon in response to a *j*th event, the *j*th event being one of a total of *J* events recorded on the each of the first block and the second block;

a detection array, the detection array comprising *N* detectors, the *n*th detector being one the *N* detectors in the detection array, the *n*th detector being associated with an *n*th detector channel, the *n*th detector outputting a *j*th detection signal in response to detecting the at least one photon corresponding to the *j*th event;

a front-end array, the front end array comprising *N* front ends, the *n*th front end being one of the *N* front ends in the front end array, the *n*th front end being associated with the *n*th detector channel, the *n*th front end outputting a *j*th time pulse in response to receiving the *j*th detection signal;

a serial encoder comprising:

N time signal generators, the *n*th time signal generator inputting the *j*th time pulse on the *n*th detector channel, the *n*th detector channel being one of the *N* detector channels, the *j*th time pulse comprising a position representing a time-of-occurrence of the *j*th event, the *n*th time signal generator generating a *j*th time signal, the *j*th time signal representing a time-of-occurrence of the *j*th time pulse, the *j*th time pulse being asynchronous to a clock signal;

an address signal generator, the address signal generator generating an *n*th address, the *n*th address representing the *n*th detector channel at which the *j*th event is recorded, the address signal generator generating a *j*th address signal, the *j*th address signal comprising the *n*th address representing the *n*th detector channel at which the *j*th event is recorded, the *j*th address signal being synchronous to the clock signal; and

a detector channel signal generator, the detector channel signal generator generating a *j*th detector channel signal, the *j*th detector channel signal comprising the *j*th time signal and the *j*th address signal, the detector channel signal generator serially outputting at least one of the detector channel signals from at least one of the *N* detector channels.

22. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein at least one of the *N* front ends further comprises at least one of a preamplifier, a shaper network, a zero-crossing detector, and a constant fraction discriminator.

23. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein the scanner is adapted for use in obtaining PET images of an animal brain.

24. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 23, wherein the animal brain is a rat brain.

25. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein the serial encoder further comprises *N* energy signal generators, the *n*th energy signal generator inputting *j*th energy information on the *n*th detector channel, the *j*th energy information comprising an energy content of the *j*th event, the *n*th energy signal generator generating a *j*th energy signal, the *j*th energy signal comprising a *j*th energy pulse, the *j*th energy pulse comprising a position representing

the jth energy information, the jth energy pulse being asynchronous to the clock signal, the detector channel signal generator incorporating the jth energy signal in the jth detector channel signal.

26. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein the detector channel signal generator generates a jth packet, the jth packet comprising information representing the jth time signal and the jth address signal, the detector channel signal generator determining a duration of the packet T_{packet} in accordance with the following equation:

$$T_{packet} \langle\langle 1/(N * rate) \qquad (2),$$

N representing a quantity of channels, *rate* representing an average rate of events per detector channel.

27. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein the serial encoder further comprises a priority encoder, the time-of-occurrence of the jth event being substantially the same as the time-of-occurrence of a $(j + 1)$th event, the priority encoder disregarding one of the jth event and the $(j + 1)$th event in accordance with a priority scheme.

28. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 27, wherein the priority scheme includes the step of disregarding one of the jth event and the $(j + 1)$th event associated with a lower address.

29. A compact conscious animal positron emission tomography (PET) scanner for acquiring a portion of a conscious animal as defined in Claim 21, wherein

the front-end array and the serial encoder are adapted for implementation in an Application Specific Integrated Circuit (ASIC).

30. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein the scintillator layer comprises a scintillator array, the scintillator array comprising N crystals, the nth crystal being one of a plurality of the N crystals in the scintillator array, the nth crystal being associated with the nth detector channel, the nth crystal outputting at least one photon in response to receiving gamma radiation from a jth event.

31. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 30, wherein the scintillator array comprises lutetium oxyorthosilicate (LSO) and the detection array comprises avalanche photodiodes (APD).

32. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 21, wherein each of the first block and the second block comprises a second detection array, the scintillator layer comprising a solid block of lutetium oxyorthosilicate (LSO), the solid block of LSO comprising a first LSO surface and a second LSO surface, the detection array being substantially adjacent to the first LSO surface, the second detection array being substantially adjacent to the second LSO surface.

33. A compact conscious animal positron emission tomography (PET) scanner for acquiring images of a portion of a conscious animal as defined in Claim 30, each of the first block and the second block further comprising a second detection array and a second scintillator array.